Saskatchewan

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Agriculture Development Fund

FINAL REPORT

DEVELOP AND TEST A GRANULAR OR ANHYDROS FERTILIZER BANDING METHOD SUITABLE FOR USE IN GRASS SEED PRODUCTION AND FORAGE CROPS

19990303

Funded by
The Agriculture Development Fund

March 2001
Prepared by: PAMI

SAF
Saskatchewan Agriculture & Food

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1. Summary

Based on an initial assessment of opener field performance, three types of openers were selected for the forage fertilizer trial. The Yetter 25 wave coulter and Dutch coulter were selected for low disturbance banding with good furrow closure. In contrast, the high disturbance knife was selected due to its common availability on farms.

The addition of banded or broadcast fertilizer blends resulted in a minimum doubling of forage yields in all three crops. Broadcast ammonium nitrate blends resulted in equivalent forage yields to banded treatments except in Crested Wheatgrass where the Dutch side banding treatment exceeded the broadcast yield. Broadcast urea blends resulted in significantly lower yields in Creeping Red Fescue and Russian Wild Ryegrass but not in Crested Wheatgrass. Mid-row banding every second row resulted in significantly lower forage yields compared to mid-row banding all rows in Creeping Red Fescue and in Crested Wheatgrass, except for the Dutch treatment. However, there were no significant differences in forage yield with the Russian Wild Ryegrass with these treatments. Visual observations with mid-row banding every second row indicated that the nitrogen produced lusher, deep green plant growth on only one half of the forage row on the side adjacent to fertilizer application. Seed production was a failure in 2000 due to poor growing conditions prior to seed formation.

Project results are based on one year of data at one location. Based on these results, further trials should be conducted over at least three years to confirm these results and provide recommendations for fertilizer application for forage and seed yield.

2. Introduction

Presently the only fertilizer application methods available for grass seed or forage production are surface broadcasting or liquid surface banding. These methods have been proven inefficient in annual cropping systems and are now rarely used in this situation. Because of recent dramatic increases in fertilizer prices, efficient usage has become even more important.

Since grasses may be sown on 2 ft row spacing, broadcasting urea or liquid N fertilizer over the entire surface may lead to volatilization, run-off during heavy rains and dramatically increased weed problems. With the decrease in availability of ammonium nitrate (34-0-0), the producer is left with urea (46-0-0) as his option for broadcasting urea is subject to volatilization losses, which decreases the benefit of the fertilizer.

Banded fertilizer could provide the producer with an economic alternative for fertilizer usage. However, soil in well established grass fields is often hard and can be quite dry and banding can pose problems with penetration, adequate fertilizer coverage and soil roughness. Many banding units have been developed for minimum tillage application and some of these openers may be suitable to adapt to this purpose. Proper placement would allow the use of urea (46-0-0) rather than the more expensive and less available 34-0-0.

The goal of this project was to evaluate a selection of openers for soil penetration and then chose the best performer for the forage fertilizer application trial.

3. Project Description

3.1 Selection of Openers

Five different styles of openers were chosen for the preliminary tests. There were two Yetters (one ripple disc and one 25 wave disc), a Bourgault mid-row bander, a Dutch coulter and a Bourgault knife (shown in **Figures 1** to **5**). The openers were operated in a Russian Wild Ryegrass field at Dale Pocock's farm at Nipawin, Saskatchewan during the first week of May 2000. Opener performance was evaluated by PAMI staff and Dale Pocock. It was based on the opener's ability to penetrate the soil and create a zone for the fertilizer with a minimum amount of soil disturbance and to leave the fertilizer covered in the furrow.

Figure 1. Yetter Ripple in the Foreground. (Yetter 25 Wave in the Background.)

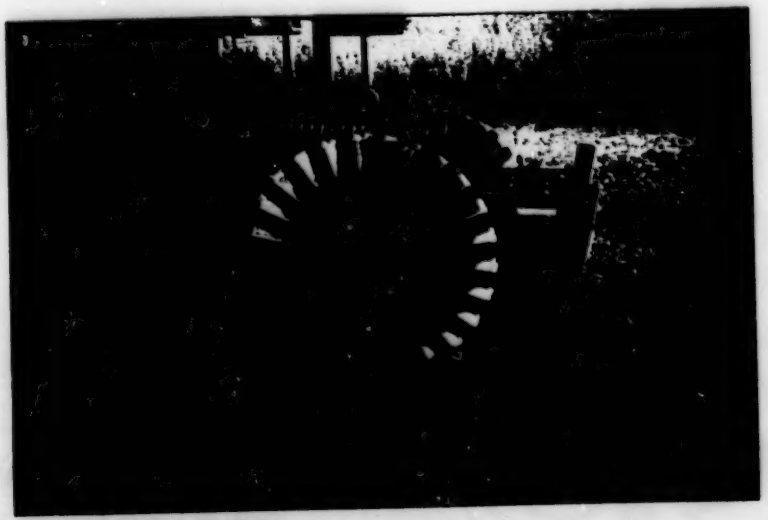

Figure 2. Yetter 25 Wave.

Figure 3. Bourgault Mid-row Bander.

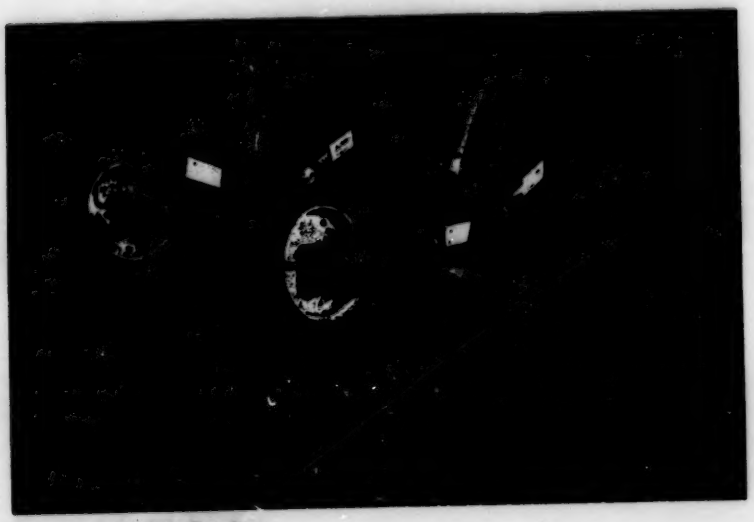

Figure 4. Dutch Coulter.

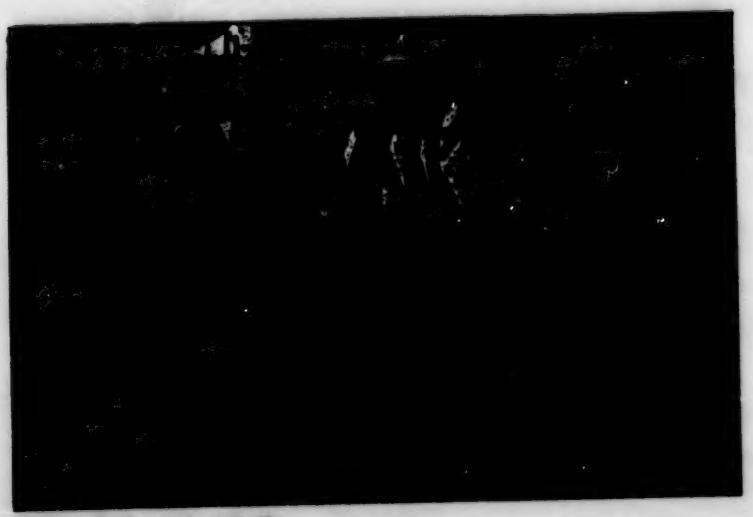

Figure 5. Bourgault Knife.

3.2 Fertilizer Yield Trials

The selected openers were mounted on the PAMI Plot Drill (**Figure 6**) and used to band fertilizer in three different grass seed fields and to compare the results to broadcast ammonium nitrate (34-0-0) and broadcast urea (46-0-0) blends. An untreated check was left for comparison. Fertilizer treatments were applied in the first week of May 2000. Urea and ammonium nitrate were (separately) blended with P, K and S and the blend applied at the following rate/ac (ha): 90 lb (41 kg) of nitrogen, 30 lb (14 kg) of phosphate, 25 lb (11 kg) of potash and 15 lb (7 kg) of sulphur. The ammonium nitrate blend was only used as a broadcast treatment while all other treatments used the urea blend.

The three fields were Mayak Russian Wild Ryegrass (seeded in 1984), Hycrest Crested Wheatgrass (seeded in 1991) and Boreal Creeping Red Fescue (seeded in 1996). The fields were initially seeded for seed production at 2 ft (610 mm) row spacings. Fertilizer treatments were applied using a randomized, complete block design with four replicates. The fertilizer treatments are shown in **Table 1.**

Table 1. Fertilizer Treatments in Each of the Three Grass Fields in Crested Wheatgrass.

	Crested Wheatgrass Treatment	Creeping Red Fescue Treatment	Russian Wild Ryegrass Treatment
Yetter 25 wave			
MRB Every 2nd	1	1	1
MRB all	2	2	2
SB	3		
Dutch			
MRB Every 2nd	4	3	3
MRB all	5	4	4
SB	6		
Bourgault Knives			
MRB Every 2nd	7	5	5
MRB all	8	6	6
SB	9		
Broadcast			
46 Blend	10	7	7
34 Blend	11	8	8
Disturbed checks			
Yetter			
MRB all	12	9	9
SB	13		
Knives			
MRB all	14	10	10
SB	15		
Undisturbed check	16	11	11

MRB Every 2nd - Mid-Row Banded every second row
MRB All - Mid-Row Banded every row
SB - Banded within two inches of every row
Disturbed checks - openers used in descriptions above without fertilizer

Forage yields were taken by the Saskatchewan Forage Council on July 24, 2000, using a small plot forage harvester. Two rows, 50 ft long (15.3 m), were harvested for yield, crude protein and neutral and acid detergent fibre. Seed yields were not taken as very few seed heads developed due to drought stress in the fall of 1999 and during seed initiation.

A non-replicated demonstration was done in an old Meadow Brome field (seeded in 1987). No rows were evident as the field was overgrown. The same rates/ac were applied as in the other fields; however, the treatments were applied at 1 ft (305 mm) spacings rather than 2 ft (610 mm) spacings used in the replicated exponents.

Figure 6. PAMI Plot Drill.

3.3 Power Tests

A load cell was mounted between the PAMI Plot Drill and the tractor. The load was recorded on a data acquisition system mounted in the tractor cab. Power data was recorded using two openers at 2 and 3 mph (3.2 and 4.8 km/h) on the Dutch (at mid-angle), Yetter 25 wave and the Bourgault knife. Rolling resistance was also recorded on the drill with no openers. The openers were set at the same depth but downward spring pressure resulted in different working depths. The draft measurements were taken side by side to try to eliminate differences in soil conditions.

4. Results and Discussion

4.1 Opener Selection

The openers were operated in a very fine sandy loam soil at 2 mph (3.2 km/h). The conditions during application were dry from the surface to about 1.5 in (38 mm) and below 1.5 in (38 mm) there was slight moisture but not enough to create any sticking. This soil usually becomes very hard during the summer and fall when it dries out. Although the soil was dry at the time of application, it was not baked hard.

The openers were mounted on the PAMI plot drill. Because of the different mounting hardware, the openers were attached so that the maximum depth possible was at the maximum of the shallowest opener at approximately 3 in (76.2 mm). With any of the openers spring deflection resulted in a depth of less than 3 in (76.2 mm).

4.1.1 Yetter

The Yetter is a commercially available fertilizer banding unit that uses a vertically mounted disc that runs straight in the direction of travel. The disc opening, penetration, aggressiveness and fertilizer placement can be varied by choosing different discs from smooth to varying degrees of ripple or waves. Discs are also available in various diameters. The disc mount on the hub did not centre the disc; therefore the disc had to be centred by moving it on the wheel bolts, which was inconvenient. Rubber or steel wheels are available as an option for closing the furrow left open by the disc. They were not used for these tests. The Yetter tests were conducted with 18 in (457 mm) blades with the following specifications.

Yetter Ripple Blade: The rippled disc created approximately a 3/8 in (9 mm) wide trench at the soil surface (**Figure 7**). Total soil disturbance on the surface was minimal at approximately 2 in (50.8 mm) injection depth. It ran straight through the soil, so disturbance was even on both side of the cut. Maximum penetration of this opener was about 2 in (50.8 mm) due to tripping of the down pressure spring.

Figure 7. Yetter Ripple Blade Soil Disturbance.

Yetter 25 Wave Blade: The Yetter 25 wave was more aggressive than the ripple and disturbed more of the soil surface. It worked the side of the furrow as it went through the soil (**Figure 8**). In the dry conditions this was a benefit as the crumbled soil fell back into the trench preventing possible fertilizer losses. In wetter soils that would not flow back into the furrow, this may leave the furrow too wide open as was found near the plots at the end of the trials (**Figure 9**). Total soil disturbance on the surface was approximately 5 in. The opener ran straight through the soil, so disturbance was even on both sides of the cut. Maximum penetration of the opener was about 2.5 in (63.5 mm) due to tripping of the down pressure spring.

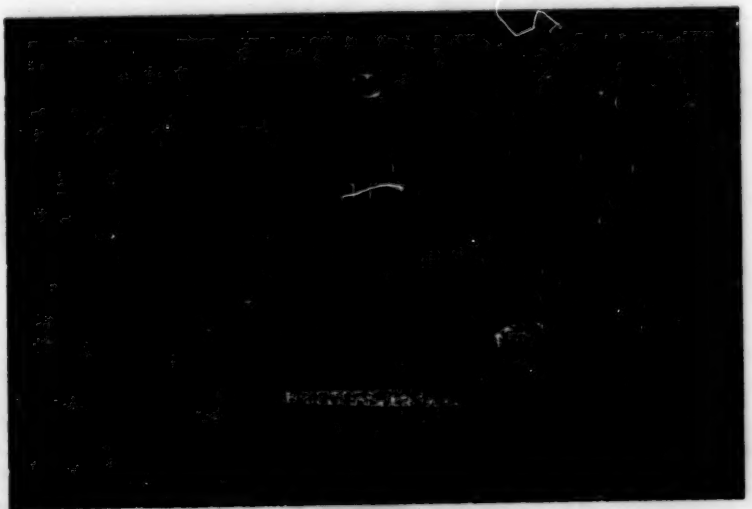

Figure 8. Yetter 25 Wave Blade Soil Disturbance.

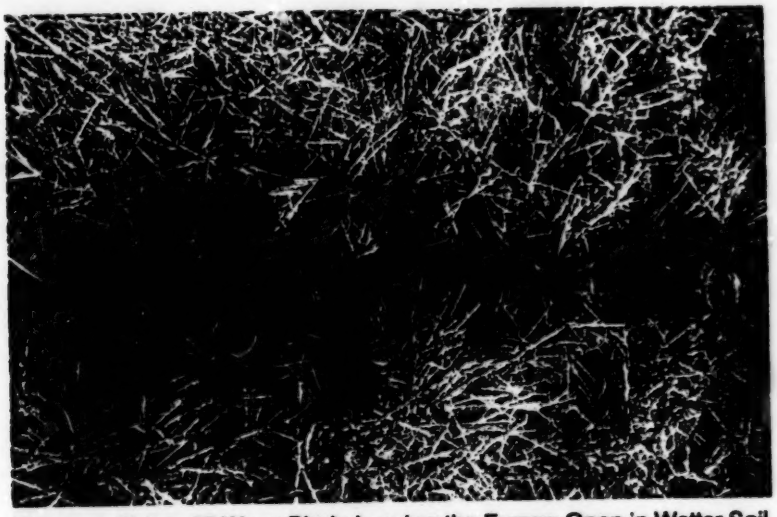

Figure 9. Yetter 25 Wave Blade Leaving the Furrow Open in Wetter Soil.

4.1.2 Dutch Coulter

The Dutch coulter is a commercial seeding or fertilizer-banding opener that uses a single 18 in (457 mm) disc with a rubber closing wheel on the side of the disc. In addition to the disc system, there is an optional packer wheel that firms up the soil following the disc. The disc operates at a slight angle to the direction of travel creating an opening for the placement of fertilizer. The disc system can be adjusted latterly from the vertical axis; this provides a wider slot that can be adjusted from the vertical plane to an angle underneath the soil. This may also provide a downward force (suction) on the disc.

In the vertical position, performance of the Dutch was typical of an angled disc in that it moved the soil to the one side and in these conditions the soil was not free to flow back and cover the furrow. This resulted in approximately ¾ in (19 mm) wide slot that was open to about three-quarters of the depth of the 3.5 in (88.9 mm) cut.

The best performance was with the disc angle adjusted to the middle position. This lifted the soil creating a furrow under the soil surface for fertilizer placement, which was pushed down and closed by the packer wheel. This resulted in a 3 in (76.2 mm) deep furrow and approximately 2 in (50.8 mm) soil disturbance on the surface (**Figure 10**).

Figure 10. Dutch Coulter Soil Disturbance (screwdriver shows angle of disc penetration).

4.1.3 Bourgault Mid-row Bander

The Bourgault mid-row bander is a commercial fertilizer-banding opener that uses a single 19 in (483 mm) disc operating at a slight angle to the direction of travel. The slight angle to the direction of travel creates the opening for the fertilizer. The soil is thrown to one side of the furrow and did not flow back into the furrow. This left a 5/8 in (15.8 mm) opening at the top of the furrow down to near the bottom of the furrow at 3 in (76.2 mm). Total soil disturbance at the surface was 5 in (127 mm) (**Figure 11**).

Figure 11. Bourgault Mid-row Bander Soil Disturbance.

4.1.4 Bourgault Knife

The Bourgault knife is a typical commercially available seed/fertilizer application tillage tool. It was mounted on a Bourgault shank. Soil flowed around the opener, leaving the furrow covered at 3 in (76.2 mm) deep. Soil disturbance on the surface was greater than the other openers with a total soil disturbance of approximately 10 in (254 mm) (Figure 12).

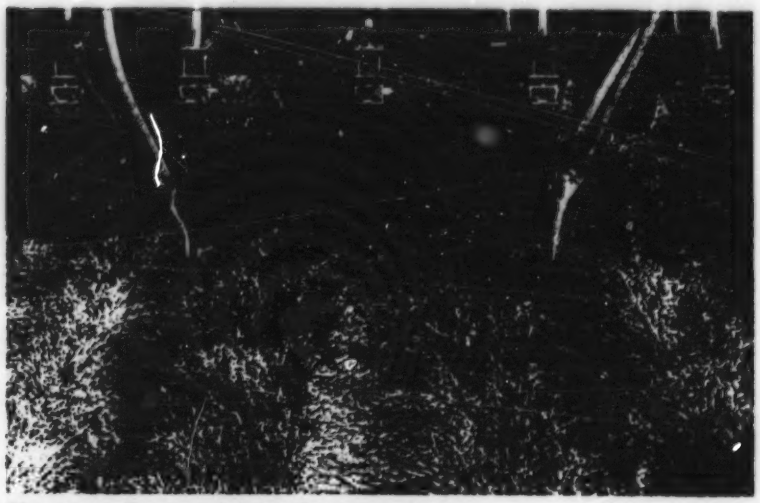

Figure 12. Bourgault Knife Soil Disturbance.

4.2 Openers Selected for the Fertility Trials

The proposal called for one opener to be selected for yield trials. However in discussion with Dale Pocock during the testing of the openers, it was decided to select one of each different style of opener. The Dutch disc coulter was selected as it provided a smooth disc with the added benefit of being able to adjust the discs vertical angle. The disc was set at its midpoint angle adjustment and the packer wheel was used to close the furrow. The Yetter 25 wave was selected due to good furrow closure in dry conditions. The Bourgault knife was chosen in spite of high soil disturbance, because knives are widely available on many farms.

4.3 Forage Yield Results

The plots were 10 ft (3.05 m) wide by 100 ft (30.5 m) long. Two rows, 50 ft (15.24 m) long, were harvested for yield and quality analysis. The Crested Wheatgrass field was the only field with distinct rows every 2 ft (610 mm) apart and therefore was the only field that could be side banded (SB) beside the grass row (**Figure 13**). Other treatments included mid-row banding every row (MRB All) (**Figure 14**), mid-row banding every second row (MRB Every 2nd) (**Figure 15**) and broadcasting (**Figure 16**). There were 16 Crested Wheatgrass treatments and 11 Creeping Red Fescue and Russian Wild Ryegrass treatments. **Figure 17** shows the rows grown together in the Creeping Red Fescue and why side banding was not an option.

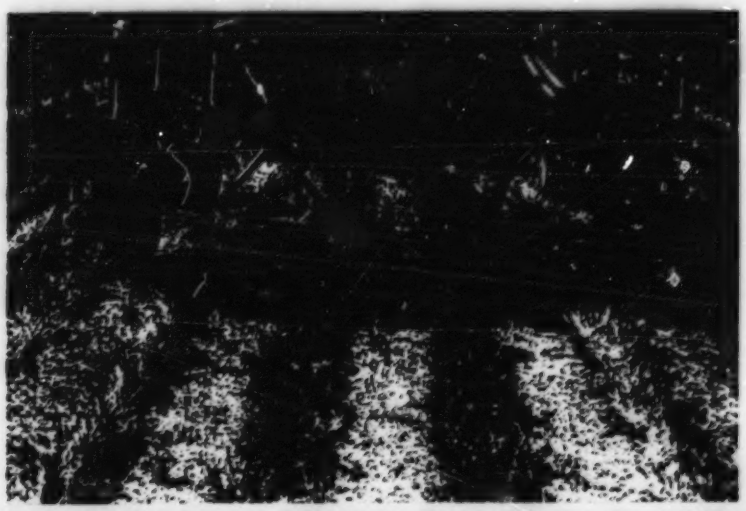

Figure 13. Side Banding (SB) with the Bourgault Knife in Crested Wheatgrass.

Figure 14. Mid-row Banding Every Row (MRB All) with the Bourgault Knife in Crested Wheatgrass.

Figure 15. MRB Every 2nd with the Bourgault Knife in Crested Wheatgrass.

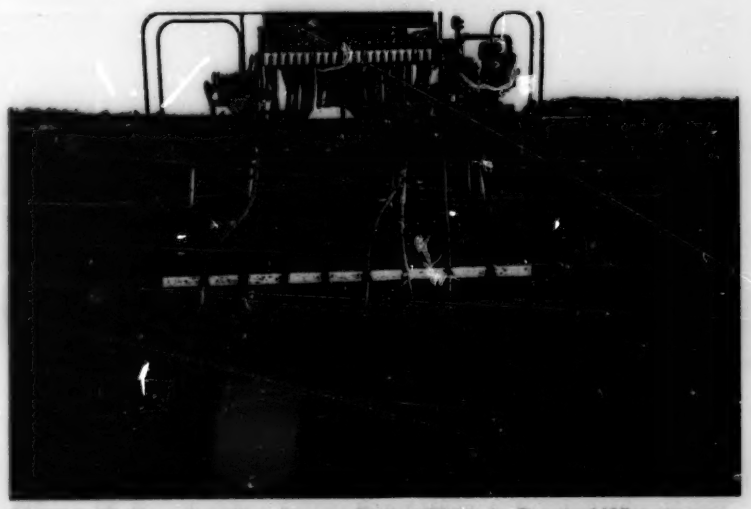

Figure 16. Broadcasting Across Entire Width in Crested Wheatgrass.

Figure 17. Lack of Distinct Rows in the Creeping Red Fescue.

4.3.1 Crested Wheatgrass Forage Yield Results

All fertilizer treatments resulted in significantly higher forage yields compared to the disturbed and undisturbed check (**Figure 18** - see **Appendix I** for detailed results). Minimum forage yield of the lowest yielding fertilized treatments was at least double the forage yield of the unfertilized check treatments. Broadcast ammonium nitrate and urea blends had equal or higher forage yields compared to the banded treatments, except for the Dutch SB treatment, which had significantly higher forage yields than all other treatments. The mid-row band "all" treatments forage yield was significantly higher than the mid-row band "every second row", except for the Dutch treatment where there was no significant difference in forage yield. The knife treatment had significantly lower yields compared to the other banded treatments, likely due to the higher soil disturbance with the knife. Crude protein increased, compared to the checks, for all fertilized treatments.

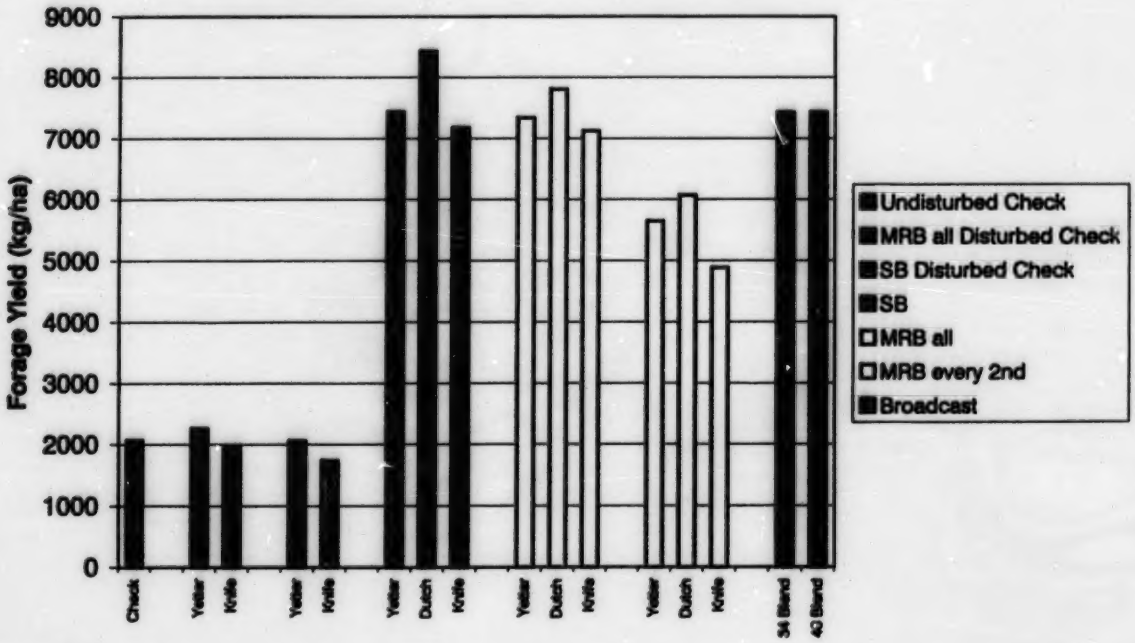

Figure 18. The Effect of Fertilizer and Soil Opener on Crested Wheatgrass Forage Yield (kg/ha x 0.89 = lb/ac).

4.3.2 Russian Wild Ryegrass

All banded and broadcast fertilizer treatments resulted in significantly higher forage yields compared to the disturbed and undisturbed checks (**Figure 19** - see **Appendix I** for detailed results). The lowest forage yield from the fertilizer treatments was more than double the best check forage yield. The broadcast urea blend forage yield was significantly lower than the forage yield from the broadcast ammonium nitrate blend and all of the MRB All treatments. Forage yield from the broadcast ammonium nitrate treatment was equal to the best banded fertilizer treatment. Crude protein was higher in all banded treatments compared to the check. The side banding treatment was not used in this trial, as the rows were overgrown due to the age of the stand.

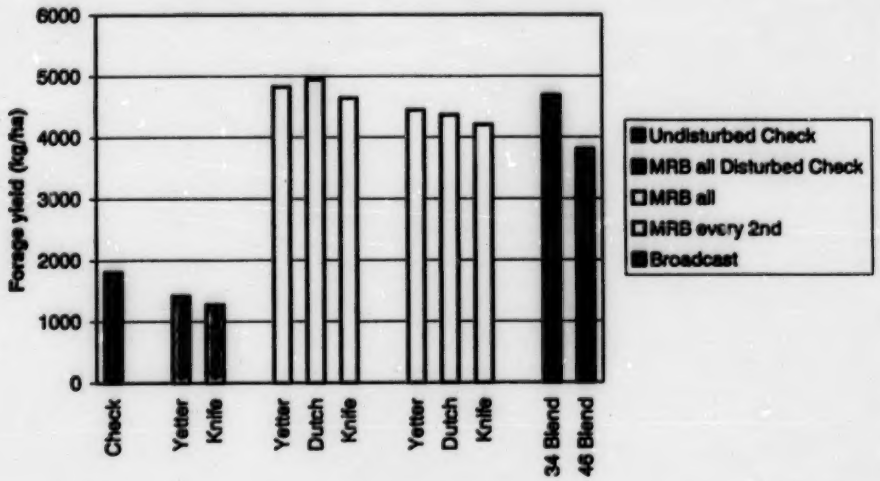

Figure 19. The Effect of Fertilizer and Soil Opener on Russian Wild Ryegrass Forage Yield (kg/ha x 0.89 = lb/ac).

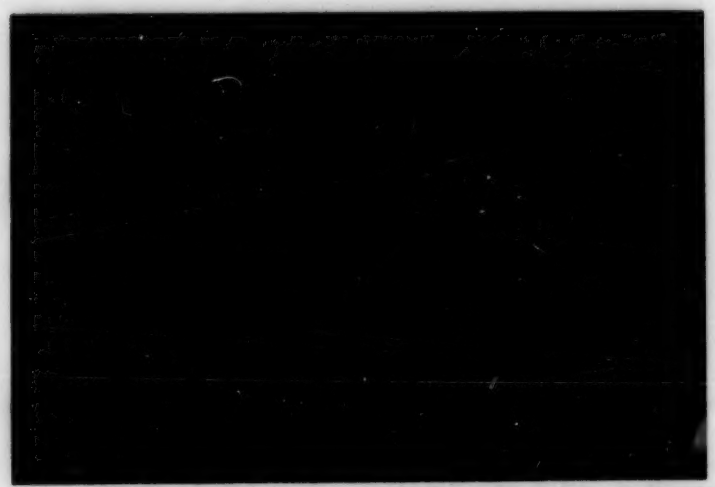

Figure 20. Green Growth through Half the Plant Row in Russian Wild Ryegrass Due to MRB Every Second Row. (Note coulter disturbance still visible.)

4.3.3 Creeping Red Fescue

Similar to the other trials, all banded and broadcast fertilizer treatments resulted in significantly higher yields compared to the disturbed and undisturbed checks (**Figure 21** - see **Appendix I** for detailed results). The lowest forage yield from the fertilized treatments was more than triple the best check forage yield. The broadcast ammonium nitrate blend and Dutch MRB All treatments significantly out yielded all of the MRB Every 2nd treatments. Similar to the Russian Wild Ryegrass trial, the forage yield from the broadcast ammonium nitrate treatments was significantly higher than the forage yield from the broadcast urea blend treatments. Crude protein increased, compared to the checks, for all fertilized treatments.

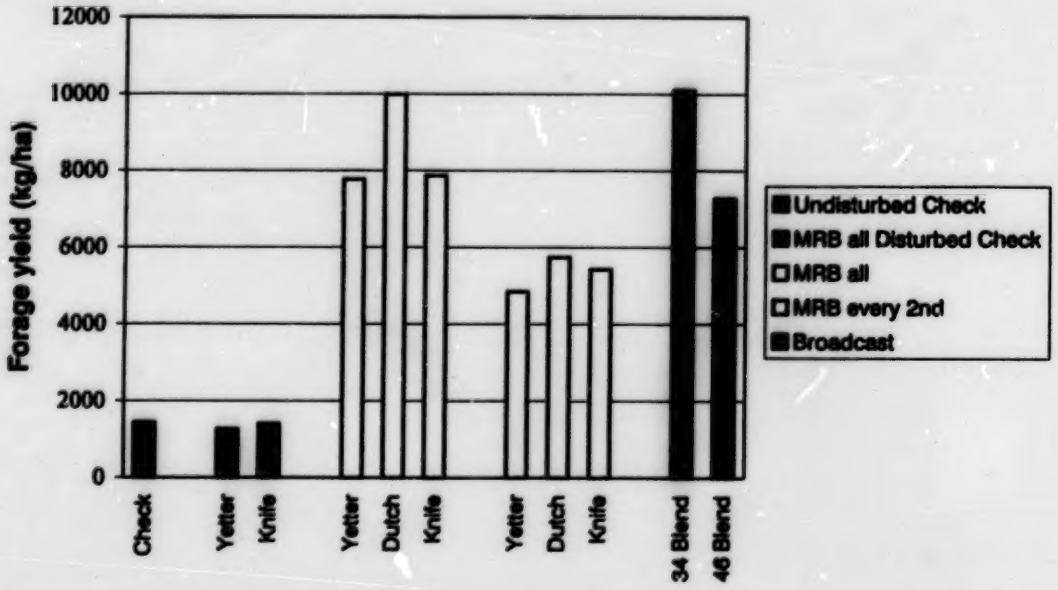

Figure 21. The Effect of Fertilizer and Soil Opener on Plant Biomass Creeping Red Fescue Forage Yield (kg/ha x 0.89 = lb/ac).

4.3.4 Meadow Brome

A small, non-replicated test was initially treated for a visual demonstration. As the field was old and fully overgrown, the same rate of fertilizer (as the other experiments) was applied on 1 ft (305 mm) spacings. There was a visual response to the treatments, so yield samples were harvested by Dale Pocock of Sunny Bank Seed Farms.

All fertilized treatments resulted in much higher forage yields compared to the check with a minimum of 3.7 x increase in yield compared to the check. The broadcast urea blend had much lower forage yields compared to the other fertilized treatments.

Table 2. Meadow Brome Yield Results (Non-Replicated).

Treatment	Yield (gr of DM)
Check	25
46 Broadcast	94
Yetter	120
Bourgault Knife	120
Dutch Disc	132
34 Broadcast	136
gr of DM = grams if dry matter.	

4.4 Power Measurements

Previous draft measurements taken by PAMI have shown results for the same cultivator in the same field may vary by as much as 30% in two different years due to changes in soil conditions. The Standard Deviation shown in **Appendix II** illustrates the variation in the draft measurements. Because of this fluctuating load, the draft measurements should only be used as a guide of what the actual loads may be. Different soil conditions will also affect the draft results; therefore, these findings will only be comparative for this soil type. The knife caused the most soil disturbance and had the highest draft. The Yetter wave also created more soil resistance than the smooth Dutch disc. The Dutch disc measured approximately one half of the draft of the other two openers. However, the Dutch was also at a slightly shallower depth due to spring deflection. Speed change from 2 to 3 mph (3.2 to 4.8 km/h) did not seem to have a large effect on draft measured (**Figure 22** - see **Appendix II** for detailed results).

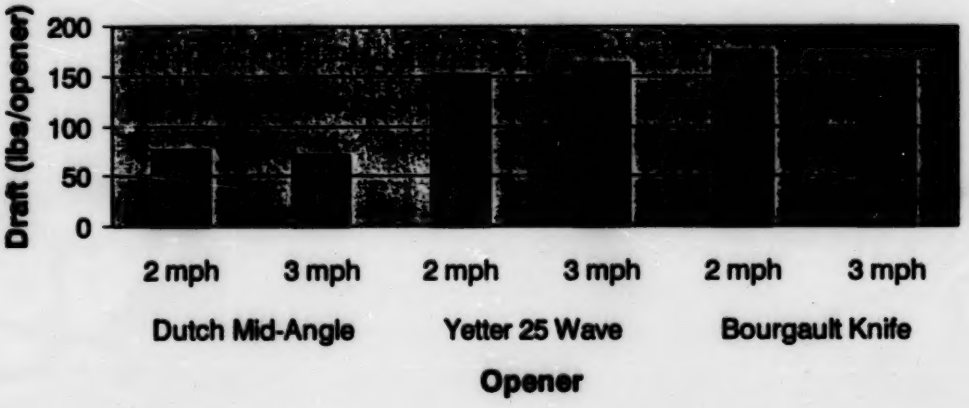

Figure 22. Results of Power Measurements (lb/opener x 0.454 = kg/opener).

5. Conclusions

5.1 Openers Selection

Based on an initial assessment of field performance in dry soil conditions, three types of openers were selected for the forage fertilizer trial. The Yetter 25 wave and Dutch coulter were selected due to good furrow closure. In contrast, the high disturbance knife was also selected due to its wide availability on farms.

5.2 Forage Yield Results

The addition of banded or broadcast fertilizer blends resulted in a minimum doubling of forage yields in all three forages. Broadcast ammonium nitrate fertilizer blends resulted in equivalent yields to banded blends in the Creeping Red Fescue and Russian Wild Ryegrass and were only exceeded in forage yield by the Dutch SB treatment in the Crested Wheatgrass. Broadcast urea blends resulted in significantly lower forage yields in Creeping Red Fescue and Russian wild Ryegrass but not in Crested Wheatgrass. The reason for the lower yields with the broadcast urea blend is likely due to volatilization loss of the urea. Mid-row banding every second row resulted in significantly lower forage yields compared to mid-row banding all rows in Creeping Red Fescue but not in the other two forages. Visual observations with mid-row banding every second row indicated that the nitrogen produced a lusher, deeper green plant growth on only one half of the forage row. Side banding may also have added benefit for use with non-translocatable mineral nutrients such as phosphate and potash. This may be more obvious in seed production, which was not available due to poor rainfall this year.

The excellent overall performance of the broadcast ammonium nitrate blends was somewhat a surprise, as broadcast fertilizer requires rainfall to move it into the root zone. This good performance was likely based on weather conditions after fertilizer application and may not be repeated in other years. Ammonium nitrate fertilizer, due to incompatibility with urea, lower analysis and higher cost, is not commonly available and must be specially ordered. So, ammonium nitrate may not be an option especially for farmers who cannot handle semi-loads of product. Seed yields were not taken due to poor seed production results from environmental stress during seed formation.

Project results are based on one year of data. Based on the opener information and these results, further trials should be conducted over at least three years to confirm these results and provide recommendations for fertilizer application rates and method for forage and seed yield.

5.3 Draft Measurements

The Dutch coulter had the lowest draft of the openers used. However, previous draft measurements taken by PAMI have shown results for the same cultivator in the same field may vary by as much as 30% in two different years due to changes in soil conditions. Therefore to get any meaningful data comparing openers, a multi-year study is required and may still be inconclusive if the openers are very similar.

APPENDIX I

Appendix I

Opener Data

Table 3. The Effect of Fertilizer and Soil Opener on Plant Biomass Crested Wheatgrass Forage Yield.

Variety	Cut #1 Forage Yield (kg DM/ha)	Significant Difference	Crude Protein (%) DM Bas	Neutral Detergent Fibre (%) DM Bas	Acid Detergent Fibre (%) DM Bas
Undisturbed Check	2069	e	8	59	33
Disturbed Check MRB All					
Yetter	2259	e	9	59	34
Knife	1946	e	7	59	35
Disturbed Check SB					
Yetter	2057	e	9	58	33
Knife	1740	e	10	58	32
SB					
Yetter	7435	b	13	57	29
Dutch	8805	a	14	57	28
Knife	7176	b	15	56	27
MRB All					
Yetter	7339	b	13	57	29
Dutch	7807	b	11	58	31
Knife	7123	b	13	57	29
MRB Every 2nd					
Yetter	5647	c	14	56	28
Dutch	6070	b	15	55	27
Knife	4886	d	16	55	26
Broadcast					
34 Blend	7424	b	11	58	29
46 Blend	7428	b	12	57	29
MEAN	5451		12	57	30
C.V. (%)	12		16	2	6
LSD (0.05)	934		3	2	3

Forage Yield - kg/ha of dried material harvested from the plot
Significant Difference - The same letter indicates there is no statistical difference in the yield data. A different letter means a statistically measurable difference.
Neutral Detergent Fibre - Total plant fibre in %
Acid Detergent Fibre - Non-digestible plant fibre in % of neutral Detergent Fibre
DM - Dry matter
SB - Side Banded within 2 in. (50.8 mm) of grass row.
MRB All - Mid-row Banded between every row.
MRB Every 2nd - Mid-row Banded every second row.
Kg DM/ha - kilograms of dry matter/hectare (kg DM/ha x 0.89 = lb DM/ac).

Table 4. The Effect of Fertilizer and Soil Opener on Plant Biomass Russian Wild Ryegrass Forge Yield.

Variety	Cut #1 Forage Yield (kg DM/ha)	Significant Difference	Crude Protein (%) DM Bas	Neutral Detergent Fibre (%) DM Bas	Acid Detergent Fibre (%) DM Bas
Undisturbed Check	1808	c	12	69	38
Disturbed Check MRB All					
Yetter	1420	c	11	69	38
Knife	1273	c	11	67	37
MRB All					
Yetter	4827	a	13	62	34
Dutch	4947	a	13	64	34
Knife	4641	a	15	62	33
MRB Every 2nd					
Yetter	4447	ab	14	62	33
Dutch	4365	ab	15	61	33
Knife	4208	ab	15	61	32
Broadcast					
34 Blend	4689	a	12	64	35
46 Blend	3810	b	12	64	34
MEAN	3676		13	64	35
C.V. (%)	15		10	2	3
LSD (0.05)	775		2	3	3

Forage Yield - kg/ha of dried material harvested from the plot
Significant Difference - The same letter indicates there is no statistical difference in the yield data. A different letter means a statistically measurable difference.
Neutral Detergent Fibre - Total plant fibre in %
Acid Detergent Fibre - Non-digestible plant fibre in % of neutral Detergent Fibre
DM - Dry matter
SB - Side Banded within 2 in. (50.8 mm) of grass row.
MRB All - Mid-row Banded between every row.
MRB Every 2nd - Mid-row Banded every second row.
Kg DM/ha - kilograms of dry matter/hectare (kg DM/ha x 0.89 = lb DM/ac).

Table 5. The Effect of Fertilizer and Soil Opener on Plant Biomass Creeping Red Fescue Forage Yield.

Variety	Cut #1 Forage Yield (kg DM/ha)	Significant Difference	Crude Protein (%) DM Bas	Neutral Detergent Fibre (%) DM Bas	Acid Detergent Fibre (%) DM Bas
Undisturbed Check	1443	d	6	61	39
Disturbed Check MRB All					
Yetter	1269	d	7	59	37
Knife	1409	d	6	59	37
MRB All					
Yetter	7775	b	12	61	35
Dutch	9991	a	11	63	37
Knife	7873	b	12	61	35
MRB Every 2nd					
Yetter	4848	c	14	62	37
Dutch	5746	c	15	60	34
Knife	5435	c	15	60	34
Broadcast					
34 Blend	10104	a	10	63	37
46 Blend	7279	b	9	63	37
MEAN	5743		11	61	36
C.V. (%)	13		13	2	4
LSD (0.05)	1092		2	2	2

Forage Yield - kg/ha of dried material harvested from the plot
Significant Difference - The same letter indicates there is no statistical difference in the yield data. A different letter means a statistically measurable difference.
Neutral Detergent Fibre - Total plant fibre in %
Acid Detergent Fibre - Non-digestible plant fibre in % of neutral Detergent Fibre
DM - Dry matter
SB - Side Banded within 2 in. (50.8 mm) of grass row.
MRB All - Mid-row Banded between every row.
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Kg DM/ha - kilograms of dry matter/hectare (kg DM/ha x 0.89 = lb DM/ac).

APPENDIX II

Appendix II

Draft Data

Table 6. Results of Power Measurements.

Opener	Speed	Pull for Two Openers	Standard Deviation	Depth	Pull Minus Rolling Resistance for One Opener
Rolling Resistance	2 mph (3.2 km/h)	252 lb (114 kg)	144	0	
	3 mph (4.8 km/h)	285 lb (129 kg)	141	0	
Dutch Mid-angle	2 mph (3.2 km/h)	403 lb (183 kg)	156	2.0 in. (50.8 mm)	75 lb (34 kg)
	3 mph (4.8 km/h)	427 lb (194 kg)	174	1.9 in. (48.3 mm)	71 lb (32 kg)
Yetter 25 Wave	2 mph (3.2 km/h)	553 lb (251 kg)	143	2.3 in. (58.4 mm)	151 lb (68 kg)
	3 mph (4.8 km/h)	611 lb (277 kg)	157	2.2 in. (55.9 mm)	163 lb (74 kg)
Bourgault Knife	2 mph (3.2 km/h)	599 lb (272 kg)	164	2.7 in. (68.6 mm)	174 lb (79 kg)
	3 mph (4.8 km/h)	615 lb (278 kg)	166	2.6 in. (66.0 mm)	165 lb (75 kg)

APPENDIX III

Appendix III

Grainews Article

FORAGE FERTILIZER TRIALS — banding versus broadcast

Surface banding of forages (our own operation).

Last summer fertilizer trials were done here in three of our older forage stands.

The work was carried out by the Prairie Agricultural Machinery Institute (PAMI) out of Humboldt, Sask. Assistance came from Saskatchewan Agriculture and Food's Research Branch, in particular the Agriculture Development Fund (ADF).

Part of the objective was to compare broadcast applications with below-surface banding. We wanted to look at different methods so producers could assess their own situation to see if changes might be warranted.

All the fields were initially put in for seed production but now have limited potential for seed, partly because of the age of the stand, but mainly due to lack of subsoil moisture reserves.

All three fields were seeded using two-foot row spacing and lower seed populations than what we are always told to use by the academic world. Four replications were done in each of the three fields on Mayak Russian wild ryegrass (seeded in '84), Hycrest crested wheatgrass (seeded '91), and Boreal creeping red fescue (seeded '96) to assess forage production and seed production. The fertilizer was applied in the first week of May under very dry conditions.

Forage production came on well after rain from early June to mid-August. The early conditions were very dry as mentioned with virtually no subsoil moisture.

Forage yields were taken on July 24 but we did not harvest seed as moisture was too late for the development of any meaningful seed yields.

The broadcast fertilizer trials used a standard blend that included all four macro nutrients (nitrogen, phosphorus, sulphur and potash). The only variation was the source of N with urea (46-0-0) used in one set of replicates and ammonium nitrate (34.5-0-0) in the other.

When below-surface banding, PAMI staff compared the use of "knives" to two different rolling type openers in different configurations. The knife used was a standard 3/4-inch-wide banding type used in many low disturbance seeding or fertilizing setups. The rolling coulter choices were reduced to two: one using a wave (fluted) coulter to work a narrow strip of soil and the other a smooth coulter with the potential of using a closing wheel.

Banding between every other row showing only part of row responding (individual plant damage are half green, half yellow). Inset photo shows another spot in these rows.

The banding was done mid-row between every other row and between every row.

In the crested wheatgrass the plant rows were still quite narrow, so a side banding trial was done as well within a few inches on one side of each row.

As a demo trial that was not replicated, PAMI staff also banded the standard blend with urea nitrogen into an old meadow brome field with a high population due to volunteering. It was seeded in '87.

As a follow-up the PAMI staff came back later in September to do a draft test on all the openers in the test areas. Conditions had returned to hard and dry due to hot, dry weather after mid-August.

Surface conditions were noted after each pass of the different openers. As expected the knives alone could leave very rough conditions.

The pictures indicate one of the major findings — with mid-row banding it appears necessary to do the banding between every row. The comparison pictures were taken in early June but the lack of nutrients available for the whole plant row width was evident throughout the complete growing season where mid-row banding was done in every other row. The data supported this observation with significant differences in forage yields between mid-row banding of every other row (MRB) and mid-row banding between every row (MR all).

The highest forage yields were obtained where side banding was used (several inches away on one side of the row). Side banding is good because it places the nutrients closer to the plants, and the plants should be able to better access nutrients such as phosphate and maybe even potash with their lateral surface roots. Most hardy forage species have lateral surface roots and deep penetrating roots.

Seed production may have shown even greater differences.

When openers were compared, the one that could chew the slot gave the highest returns with the "tilled strip," but without chewing it generally produced slightly better results than the knife operation. In my opinion this could relate to using urea as the N source, especially when conditions are dry and warm with potential losses to the atmosphere.

Mid-row banding (below surface) between every row (uniform "grass").

Nearly always the broadcast ammonium nitrate blend greatly outperformed the broadcast urea blend, which can be expected, especially since the spring applications were not made under the best conditions. But over the years we have questioned the use of broadcast urea even when conditions appear ideal, whether in spring or fall. The need for at least one inch of moisture to move urea into the soil and help reduce losses to the atmosphere, along with the slow reaction by the crop, can take away any price advantage.

In one case in the creeping fescue trial, the 34.5-0-0 blend broadcast produced over 10,000 kilograms dry matter per hectare (kg DM/ha) — or nearly five tons per acre. The urea blend produced just over 7,000 kg DM/ha.

The next step would be to try alternative forms of nutrients such as ammonia (NH3) and/or liquid formulations. Here you would preferably have a tilled strip to cover over and seal off the applications. Ammonia should be your cheapest source of N.

We have done this already here with varying degrees of success regarding penetration, sealing off of product and surface conditions after the operation.

It has been stated before that banding can reduce the total amount of fertilizer required and still may produce similar yields as compared to total coverage. This can also discourage undesirable growth between the rows — especially important in dryland farming.

Weeds and other species are not so apt to grow near established forage plants (some forages produce toxins to protect their territory), so anything that discourages their establishment and growth between the rows can be beneficial. A "stale" seedbed and nutrients applied close to the desired plants encourage them to cover the bare ground with their foliage for greater competition.

Another possible operation could be to use rolling coulters as shields to apply non-selective herbicides with a roller between the rows.

Progressive forage producers have for some time been using lower forage stand populations spaced out to guard against drought and for the potential of having a longer productive stand. This may not be necessary under wetter conditions.

The final report I am certain will be available later from PAMI, with all the data and their professional evaluation.

Dale Pocock operates Sunny Bank Seed Farms and runs cattle near Nipawin, Sask.

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